

**RELATIONSHIPS AMONG HOLARCTIC GENERA IN THE
CYRTOGASTER-GROUP WITH A REVIEW OF THE
SPECIES OF NORTH AMERICA NORTH OF MEXICO
(HYMENOPTERA: PTEROMALIDAE)**

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Abstract.—The *Cyrtogaster*-group, which includes the genera *Cyrtogaster* Walker, *Novitzkyanus* Boucek, *Tricyclomischus* Graham, and *Callicarolynia*, n.g., is defined as containing those miscogasterine pteromalid genera that possess three symmetrically arranged clypeal denticles and a weakly sculptured petiole with a distinct median and pairs of sublateral and lateral carinae. A phylogenetic analysis of relationships among these genera and their relationships to other miscogasterine genera is presented. *Polycystus* Westwood is herein synonymized with *Cyrtogaster* Walker. Seven Nearctic *Cyrtogaster* species are treated: *C. anapodisis*, n. sp., *C. britteni* Askew, *C. capitanea*, n. sp., *C. clavicornis* Walker, *C. reburra*, n. sp., *C. tryphera* (Walker), and *C. vulgaris* Walker. Keys to the Nearctic *Cyrtogaster* species and a summary of the biology of the genus and each species are presented. A new Hawaiian species, *C. annectens*, n. sp., is also described. *Polycystus clypeatus* Girault is transferred to *Thinodytes* Graham; *Polycystus propinquus* Waterston, *Polycystus nigriscapus* Howard, and *Polycystus luteipes* Howard are transferred to *Halticoptera* Spinola; and *Polycystus nigritus* Howard belongs in a new genus near *Thinodytes* Graham. A new genus *Callicarolynia* is described to accommodate a single Nearctic species, *C. eruga*, n. sp.

While sorting museum collections during the author's continuing study of the Nearctic miscogasterine Pteromalidae, three new Nearctic *Cyrtogaster* species were found (*C. anapodisis*, n. sp., *C. capitanea*, n. sp., and *C. reburra*, n. sp.), two Palearctic *Cyrtogaster* species were found to occur in the Nearctic region (*C. britteni* Askew and *C. clavicornis* Walker), and a new Hawaiian *Cyrtogaster* species morphologically intermediate between *Cyrtogaster* and *Polycystus* Westwood was also found. Material belonging to a new Nearctic genus similar to *Cyrtogaster* was found (*Callicarolynia*, n. g.). In this paper, *Polycystus* is synonymized with *Cyrtogaster*, the four new Nearctic *Cyrtogaster* species are described, the two new Nearctic records are reported, and the new genus, *Callicarolynia*, is described containing its type species, *C. eruga*, n. sp.

Study of Palearctic miscogasterine genera at the BMNH revealed that *Novitzkyanus* Boucek and *Tricyclomischus* Graham were phenetically similar to *Cyrtogaster* and *Callicarolynia*. Cladistic analysis by the author, reported herein, supports a hypothesis that *Cyrtogaster*, *Novitzkyanus*, *Callicarolynia*, and *Tricyclomischus* form a single monophyletic generic cluster defined by the following two synapomorphies: 1) three symmetrically arranged teeth or lobes on the anterior margin of the clypeus (Fig. 2) and 2) a weakly sculptured petiole with a distinct median carina and pairs of diverging submedian and lateral carinae extending its entire length (Fig. 3). Prior to this study, *Cyrtogaster*, *Novitzkyanus*, and *Tricyclomischus* were not thought to be closely related

genera. Graham (1969) placed *Tricyclomischus* in the Miscogasterini and *Cyrtogaster* and *Novitzkyanus* in the Sphegigasterini. The genera of the *Cyrtogaster*-group can be differentiated by the characters given in Table 1.

Two related genera, *Syntomopus* Walker and *Nodisoplata* Graham, with three symmetrically arranged anterior clypeal denticles were not included in this generic group because other characters show that their petiole structure differs from that given above and because their closest affinities lie in other generic groups. *Syntomopus* belongs with those genera similar to *Halticoptera* Spinola because of similarities in the structure of the propodeal carinae and because the hind margin of the first gastral tergum is sinuous laterally and emarginate medially. *Nodisoplata* is morphologically identical to *Seladerma* Walker except for the symmetrical arrangement of the clypeal denticles.

The genus *Novitzkyanus* contains two described species, *N. cryptogaster* Boucek (1961) from Europe and *N. tridentatus* Delucchi (1962a) from Morocco. *Tricyclomischus* is monotypic, with only *T. celticus* Graham (1956) from the United Kingdom. The genus *Callicarolyntia* is also monotypic, containing only *C. eruga* from the United States and Canada. *Cyrtogaster* contains nine described species: *C. annectens* from the Hawaiian Islands; *C. britteni* Askew (1965), *C. clavicornis* Walker (1833), and *C. vulgaris* Walker (1833) from the Holarctic region; *C. mallorcensis* Askew (1975) from the Palearctic region; *C. nigra* (Risbec, 1955) from the Ethiopian region; *C. javensis* Girault (1915) from the Oriental region; *C. fluitantis* De Santis (1972) and *C. santaclarae* De Santis (1964) from the Neotropical region; and *C. anapodis*, *C. capitanea*, *C. reburra*, *C. tryphera* (Walker, 1843) from the Nearctic region.

Based on examination of their type specimens in the USNM and the BMNH, *Polycystus clypeatus* Girault (1918) is transferred to *Thinodytes* Graham; *Polycystus propinquus* Waterston (1915), *Polycystus nigriscapus* Howard (1897), and *Polycystus luteipes* Howard (1897) are transferred to *Halticoptera* Spinola; and *Polycystus nigrilus* Howard (1897) belongs in a new genus near *Thinodytes* Graham. Species of *Polycystus* for which generic placement is uncertain include *P. ivondroi* Risbec (1952), *P. madagascariensis* Risbec (1959), and *P. pauliani* Risbec (1959) from the Ethiopian region.

Terminology in this paper generally follows that of Graham (1969), except that genal concavity is used instead of genal hollow and club is used instead of clava. In addition, the gastral terga are numbered 1–7 beginning with the first tergite after the petiole. The following abbreviations are used: the median ocellar diameter is MOD, ocell-ocular distance is OOL, posterior ocellar distance is POL, lateral ocellar distance is LOL, multiporous plate sensillae are MPP sensillae, lower ocular line is LOcL, antennal funicular segments are F1 through F6, and the gastral terga are T1 through T7. The units of measurement given in the descriptions can be converted to millimeters by multiplying by 0.02.

The author's concept of *Tricyclomischus celticus* is based on a pair of specimens on loan from the BMNH that were collected at Awbridge, Romsey, Hampshire, England in September 1980 by C. Vardy, and determined by Z. Boucek. The concept of *Novitzkyanus cryptogaster* is based on a female from Moncada, Spain, collected 14 September 1978 from a calliphorid in a snail by M. J. Verdue, and a male from St. Chamas (near Marseilles), France, collected 9 June 1973 by Z. Boucek. These two specimens were determined by Z. Boucek, and were on loan to the author from

Table 1. Character comparisons among the genera *Tricyclomischus* Graham, *Cyrtogaster* Walker, *Novitzkyanus* Boucek, and *Callicarolyntia* n.g.

Character	<i>Tricyclomischus</i>	<i>Cyrtogaster</i>	<i>Novitzkyanus</i>	<i>Callicarolyntia</i>
Body color	dark green	blue-green to dark green	bluish gray	dark green
Clypeal margin	projecting lobes rounded	teeth sharp	teeth sharp	only middle tooth sharp
Genal hollow	absent	extending $\sim 1/3$ genal length	extending $< 1/4$ genal length	absent
Male maxillary palps	slender	globularly enlarged	slender	weakly expanded
Antennal insertion	below LOcL	at or below LOcL	above LOcL	below LOcL
First funicular segment	small, nearly annelliform	same size as second	same size as second	same size as second
Male flagellum	similar to that of females	similar to that of females	pedunculate w. erect setae	similar to that of females
Pronotal collar	acarinate	carinate	carinate	acarinate
Scutellar setae	4 pairs	4-5 pairs	2-3 pairs	4-many pairs
Basal cell	setate	setate to bare	bare	setate
Postmarginal vein length	longer than marginal vein	shorter than marginal vein	shorter than marginal vein	shorter than marginal vein
Petiole proportions	transverse	elongate to transverse	elongate	transverse
Lateral patch of setae on T1	extensive but sparsely setate	poorly developed	poorly developed	well developed
Hind margin of T1	weakly concave	concave	straight	straight
Length of T1	$< 1/2$ gastral length	$< 1/2$ gastral length	covering entire gaster	covering entire gaster

the BMNH. Two female and one male *N. cryptogaster* specimens from Valencia, Spain, collected in November 1916 by E. A. Beck from a snail infested by Diptera (USNM) were also seen. The authors concept of *Cyrtogaster* is based on the *Cyrtogaster* species treated in this paper.

PHYLOGENETIC ANALYSIS OF THE *CYRTOGASTER*-GROUP GENERA

For the phylogenetic analysis of the genera of the *Cyrtogaster*-group, a character matrix was constructed by scoring the four genera of the *Cyrtogaster*-group and five outgroup genera for 21 characters. The five outgroup taxa were chosen to represent four of the generic groups within the tribes Miscogasterini and Sphegigasterini (*sensu*

Graham, 1969) as defined in Heydon (1988). *Lamprotatus* Westwood and *Miscogaster* Walker represent the *Lamprotatus*-group; *Merismus* Walker, the *Merismus*-group; *Halticoptera* Spinola, the *Halticoptera*-group; and *Sphegigaster* Spinola, the *Sphegigaster*-group. The polarity of the characters was determined with respect to *Lamprotatus*, the most primitive of the outgroup taxa used. The 21 characters and their states are listed below.

1. Body Color: green to blue-green (0); bluish gray (1).
2. Anterior Margin of Clypeus: three asymmetrically arranged denticles (0), three symmetrically arranged denticles (1), two denticles (2).
3. Denticle Shape: denticles pointed (0), denticles rounded lobes (1).
4. Genal Concavity: absent (0), slight (1), profound (2).
5. Male Maxillary Palp: slender (0), green and globularly expanded (1), yellow and lamellately expanded (2).
6. Antennal Insertion: above a line between lower orbits (0), at or below a line between the lower orbits (1).
7. First Funicular Segment: about as large as second funicular segment (0), nearly annelliform (1).
8. Male Flagellum: similar in appearance to female flagellum (0), with strong sexual dimorphism (1).
9. Pronotal Collar: pronotum declining immediately from mesoscutum (0), horizontal collar present (1).
10. Anterior Margin of Collar: lacking anterior transverse carina (0), transverse carina present (1).
11. Mesoscutal sculpture: imbricate (0), reticulate (1).
12. Scutellar Setae: four to many pairs present (0), three or fewer pairs present (1).
13. Basal Cell of Fore Wing: setate (0), bare (1).
14. Postmarginal Vein: longer than marginal vein (0), shorter than marginal vein (1).
15. Petiole Proportions: transverse (0), as long as or longer than wide (1).
16. Petiolar Carinae: carinae absent or short (0), median carina present (1), diverging sublateral and lateral carinae present in addition to median carina (2).
17. Petiolar Base: acarinate ventrally at base (0), with ventral flange at base (1).
18. Lateral Setal Patch on T1: absent or poorly developed (0), extensive (1).
19. Hind Margin of T1: straight (0), broadly concave (1).
20. Mesal Hind Margin of T1: straight (0), emarginate medially (1).
21. Length of T1 (females): < half the length of gaster (0), nearly equal to length of gaster (1).

The character matrix (Table 2) was run on the Phylogenetic Analysis Using Parsimony (PAUP) program, Version 2.4, written by D. S. Swofford (Illinois Natural History Survey). Because the data matrix was small enough, the branch and bound option was selected, thereby guaranteeing that all most parsimonious trees would be found. Three multistate characters (2, 5, and 16) were run as unordered characters because no plausible *a priori* hypothesis of character state transitions among the three character states could be made; however, the same tree was produced when character 16 was run as an ordered character. Both character states occurred in characters 13

Table 2. Character matrix for phylogenetic analysis of the *Cyrtogaster*-group.

Genus	Character state																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
<i>Lamprotatus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Miscogaster</i>	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0
<i>Merismus</i>	0	0	0	2	0	0	0	0	1	1	1	1	0	0	1	0	1	1	0	0	0
<i>Halticoptera</i>	0	2	0	2	2	1	0	0	1	0	1	1	1	1	1	1	1	1	0	1	0
<i>Sphegigaster</i>	0	2	0	2	0	0	0	0	1	0	1	0	1	1	1	0	1	1	1	0	0
<i>Cyrtogaster</i>	0	1	0	2	1	1	0	0	1	1	1	0	?	1	?	2	1	1	1	0	0
<i>Novitzkyanus</i>	1	1	0	1	0	0	0	1	1	1	1	1	1	1	1	2	1	1	0	0	1
<i>Callicarolyntia</i>	0	1	0	0	2	1	0	0	1	0	1	0	0	1	0	2	1	0	0	0	1
<i>Tricyclomischus</i>	0	1	1	0	0	1	1	0	1	1	1	0	0	0	0	2	1	0	0	0	0

and 15 in *Cyrtogaster*. These characters were coded as missing (?), thereby freeing the PAUP algorithm to select either state during tree building since no *a priori* assumptions about the primitive or advanced states of these characters within the genus were made. Although *C. anapodisis* lacks the globularly enlarged male maxillary palps characteristic of other *Cyrtogaster* species, several apomorphic characters support a relationship between it and *C. vulgaris*, the most apomorphic of the described *Cyrtogaster* species. This suggests that character 5 has reverted to the primitive state in *C. anapodisis*. Therefore, *Cyrtogaster* was coded as having state 1 for character 5 even though the genus as a whole was polymorphic for this character.

A tree of 40 steps with a consistency index of 0.625 was produced (Fig. 1, Tree A). The *Cyrtogaster*-group is defined on the tree by the symmetrical arrangement of the three clypeal denticles, the transverse carina on the pronotum, and the pattern of carinae on the petiole. The carinate pronotum is also characteristic of genera in the *Merismus*-group. Thus, either it gives evidence of a relationship between genera of the *Merismus*-group and genera of the *Cyrtogaster*-group or it has arisen independently in each group. The data set used in this analysis favors an independent origin of this character in each group.

The following two synapomorphies define *Cyrtogaster*: 1) The hind margin of T1 is broadly concave. This apomorphic character state also occurs in *Sphegigaster*. 2) The male maxillary palps are globularly enlarged, at least primitively. This apomorphic character state is also found in *Haliptogeton* De Santis (not seen) and some species of *Sphaeripalpus* Förster. *Sphaeripalpus* has other characters that place it among the genera of the *Lamprotatus*-group.

Autapomorphies defining *Novitzkyanus* are the bluish gray body color and a strong sexual dimorphism in the antennal flagellum. The antennae of female *Novitzkyanus* resemble those of other species in the *Cyrtogaster*-group (as in Figs. 8, 19); the male funicular segments, however, are pedunculate, cylindrical, 2–3 times as long as wide, and are covered with long and semierect setae. Two other apomorphies set *Novitzkyanus* off from other genera of the *Cyrtogaster*-group: the antennae are inserted in the middle of the face (a reversion to an ancestral condition), and there is a reduction in the number of pairs of scutellar setae (a common apomorphic character state).

Callicarolynia, although fairly distinct in appearance, is rather poorly defined cladistically. The two apomorphies defining this genus are the expanded maxillary palps of the males and the loss of the transverse carina on the pronotum. This latter condition is a reversion to a common plesiomorphic state. Besides occurring only in the males, the lamellately expanded maxillary palps are characteristic of *Halticoptera*, and therefore not unique to *Callicarolynia*.

Autapomorphies defining the genus *Tricyclomischus* are the rounded clypeal teeth, the reduced first funicular segment of the female antenna, and the lengthening of the postmarginal vein. This latter is a reversion to a common plesiomorphic state.

The behavior of character 21 depends on the type of optimization employed. Farris optimization would have T1 becoming elongate in the common ancestor of *Novitzkyanus*, *Callicarolynia*, and *Tricyclomischus* and then reverting to the ancestral state in *Tricyclomischus*. Another equally parsimonious change would be the independent evolution of the elongate T1 in both *Novitzkyanus* and *Callicarolynia*. I judge this latter occurrence to be more probable because a greatly elongate T1 has arisen independently in a number of other miscogasterine genera such as *Cryptoprymna* Förster, *Notoglyptus* Masi, and *Toxeuma* Walker.

One anomalous result of this analysis is the grouping of the overall rather plesiomorphic genus *Tricyclomischus* with the apomorphic *Callicarolynia*. The four character state transitions in characters 4, 13, 15, and 18, which define the branch uniting these two taxa, are all reversions to the primitive state. In addition, because of the apomorphic placement of *Callicarolynia*, character 14, the relative length of the postmarginal vein, undergoes a reversion apomorphy on the branch between *Tricyclomischus* and the common ancestor of *Callicarolynia* and *Tricyclomischus*. This character is rather constant within genera in the Miscogasterinae, which indicates it may not be readily subject to reversion. Moving *Tricyclomischus* to a more intuitively correct position at the base of the *Cyrtogaster*-group might resolve this difficulty as well as the need for a reversion to the primitive state in character 21. *Tricyclomischus* was moved to the base of the *Cyrtogaster*-group using the define tree option with PAUP. However, rerooting *Tricyclomischus* did not resolve these difficulties satisfactorily because the new analysis produced significantly longer trees. The new trees were a minimum of four steps longer than Tree A (Fig. 1, Tree B). One extra step is saved in character 21, but a step is added in characters 13, 15, and 18 and two steps are added in character 4. The reversion apomorphy in character 14 still occurs because the postmarginal vein is shortened in *Halticoptera* and *Sphegigaster*, genera ancestral to the *Cyrtogaster*-group, and a majority of the genera in the *Cyrtogaster*-group.

Cyrtogaster Walker

Cyrtogaster Walker, 1833:371, 381. Type species: *Cyrtogaster rufipes* Walker, 1833. Westwood, 1839:68; Förster, 1856:52, 53, 54–55 (synonymy); Thomson, 1878:18, 25; Ashmead, 1904:331, 332 (key); Schmiedeknecht, 1909:375, 376, 382–383; Viereck, 1916:468; Nikol'skaya, 1952:248 (key); Peck, 1963:14, 626; Peck et al., 1964:38 (key); Askew, 1965:179–195; Graham, 1969:124, 141–144; Dzhanokmen, 1978:77 (key); Burks, 1979:787.

Polycystus Westwood, 1839:68. Type species: *Polycystus matthewsii* Westwood, 1839. Thomson, 1878:18, 26; Ashmead, 1904:331, 332; Schmiedeknecht, 1909:375, 376,

380–381; Graham, 1956:261; Peck et al., 1964:38; Askew, 1965:183–184; Graham, 1969:124, 144; Dzhanokmen, 1978:77 (key). **New Synonym.**

Dicormus Förster, 1840:38. Type species: *Dicormus aquisgranensis* Förster, 1840. Förster, 1856:55.

Hatia Risbec, 1955:248. Type species: *Hatia nigra* Risbec, 1955. Boucek, 1976:14.

Description. Color: Head, mesosoma, coxae, petiole metallic blue-green to dark green; gaster dark metallic green to black.

Female. Head transversely oval to more pentagonal, often weakly protuberant at level of antennal insertions; antennal scrobes deep so head length at inner orbits nearly half again its median length; clypeus usually nearly smooth with three symmetrically arranged sharp marginal denticles; gena with concavity above base of mandibles, concavity sometimes weak; eye often setate; vertex with low transverse ridge behind ocelli in *C. vulgaris* and *C. anapodisis*; occiput acarinate. Antenna inserted near level of ventral edge of eyes; formula 1:1:2:6:3; scape slender, length approximately 9× width; flagellum strongly clavate (width of club often 2× width of F1), often appearing granulate; MPP sensillae coarse, prominent, in single transverse row on each flagellar segment; club lacking terminal spine or large patch of micropilosity (though a small patch is present on apical segment in *C. vulgaris*), blunt apically. Mandibles four-toothed. Mesosoma flattened dorsally in *C. britteni*; pronotum with collar separated from neck by transverse carina, collar smooth posterior of carina; notauli usually complete but indistinct posteriorly in *C. capitanea* and *C. vulgaris*; scutellum as long as wide, with four to many pairs of lateral setae, frenal sulcus complete and distinct; propodeum rugulose but median carina and plicae usually traceable, spiracle circular to shortly ovate, callus with setae relatively dense, nucha undeveloped; mesopleuron with upper epimeron smooth. Larger species with two hind tibial spurs, smaller species with one. Fore wing with relative lengths of veins as follows: submarginal > marginal > postmarginal > stigmal; basal cell and speculum varying from completely bare (*C. capitanea*) to completely setate (*C. clavicornis*). Petiole varying from transverse to longer than wide; nearly smooth except for median, diverging sublateral, and lateral carinae (carinae poorly developed in *C. vulgaris* and *C. anapodisis*); basal ventral flange present; one pair of lateral setae present in *C. capitanea*. Gaster ovate; T1 and T2 covering nearly its entire dorsal surface; hind margin of T1 broadly concave; remainder with hind margin straight.

Male. Similar to female except flagellum parallel-sided and MPP sensillae less prominent. Maxillary palps may be totally slender (*C. anapodisis*); with segment three metallic green and globularly expanded and the fourth segment present (Fig. 5) (*Cyrtogaster sensu* authors); or with segment three metallic green and globularly enlarged, the terminal segment lost, and an additional globular lobe off the stipites (Fig. 7) (*Polycystus sensu* authors).

Discussion. Both Askew (1965:184) and Graham (1969:144) noted that the genus *Polycystus* is very similar to *Cyrtogaster* and might be reduced to a subgenus of *Cyrtogaster*. Graham (1969) separates the two genera on the basis of the pattern of setae on the fore wing and the structure of the male maxillary palp. Species in *Cyrtogaster* have a well developed speculum and at least the proximal third of the basal cell bare; the type species of *Polycystus*, *P. clavicornis* Walker, has the basal cell setate and the speculum absent. Male *Cyrtogaster* have the penultimate segment

of the maxillary palps globularly expanded and the stipites unmodified (Fig. 5), male *P. clavicornis* have the terminal segment expanded and another globular lobe from the stipites (Fig. 7). A new *Cyrtogaster* species from the Hawaiian Islands, *C. annectens*, n. sp., has the fore wing setal pattern of *Cyrtogaster* and the male maxillary palpal structure of *Polycystus*. In addition, males of the new Nearctic species *C. anapodisis*, n. sp. have maxillary palps that are slender and totally lack globular enlargement. Because of the variability in the two characters previously used to separate these two genera, the wing setation pattern and the structure of the male maxillary palps, I am synonymizing *Polycystus* Westwood with *Cyrtogaster* Walker. *Cyrtogaster* is here redefined as containing those species in the *Cyrtogaster*-group that have the hind margin of the first gastral tergum concave and otherwise agree with the characters given for *Cyrtogaster* in Table 1.

BIOLOGY OF CYRTOGASTER

Known hosts and the habits and plant associations of those hosts are presented in Table 3.

Species of this genus are pupal parasitoids of a number of different leaf-, stem-, or seed-mining Diptera or other small dipterous pupae that might be adhering to plant material, since nonleaf-mining flies of the genera *Lonchoptera* (Lonchopteridae), *Drosophila* (Drosophilidae), and *Brachydeutera* (Ephydriidae) are also recorded as hosts (Graham, 1969; Burks, 1979). An old record of *Cyrtogaster vulgaris* reared from an aphid by Haliday was questioned by Reinhard (1859), but now, after almost 130 years, Haliday may be vindicated. There is a specimen of *C. vulgaris* in the USNM which was reared from a mummy of the aphid *Macrosiphum euphorbiae* (Thomas). Such mummified aphids may sufficiently resemble fly pupae that they are occasionally parasitized by this species.

The number of instars passed by species of *Cyrtogaster* is uncertain. Cameron (1939) reported that *C. vulgaris* has a life-history "in most respects like that of *Sphegigaster flavicornis*" [= *S. pallicornis* (Spinola)], which he gave as having five larval instars. Simmonds (1952) found that *C. tryphera* had three larval instars and a resting (prepupal) stage.

Mating behavior in *Cyrtogaster* is typical for chalcidoids in general, and details for *C. tryphera* were given by Simmonds (1952). Simmonds (1952), also reported host-feeding by adult female *C. tryphera*. Askew (1965) reported *C. vulgaris* females can be taken on *Salix* catkins in the spring, so adults probably take nectar as well. Adult female *Cyrtogaster vulgaris* overwinter in various types of tufted or loose plant material such as evergreen foliage, *Carex* tufts, moss, galls, haystacks, bird nests, etc. (Askew, 1965 and VanderSar, 1978). Adults of *Cyrtogaster britteni* (Graham, 1969) and *C. tryphera* have been taken in February and March so overwintering by adults may be common in this genus. *Cyrtogaster clavicornis*, however, overwinters inside its host (Burghele, 1959).

KEY TO THE SPECIES OF CYRTOGASTER WALKER

1. Vertex with transverse ridge immediately behind posterior ocelli (Fig. 6) 2
- Vertex smoothly rounded behind posterior ocelli (Fig. 4) 3
2. Both sexes with scutellum alveolate. Notauli obscure posteriorly. Males with middle

Table 3. Biology of *Cyrtogaster* species.

<i>Cyrtogaster</i> sp.	Host	Host biology/Plant host
<i>C. anapodisis</i>	unknown	
<i>C. annectens</i>	Tephritidae	unknown/ <i>Bidens cosmoides</i> (A. Gray)
<i>C. britteni</i>	unknown	
<i>C. capitanea</i>	unknown	
<i>C. clavicornis</i> ¹	<i>Hydrellia griseola</i> (Fallén) (Ephydriidae) <i>H. nasturtii</i> (Collin)	Leaf miner/primarily Gramineae Stem miner/ <i>Nasturtium officinale</i> L.
	<i>Pegomya hyoscyami</i> Panzer (Anthomyiidae) <i>Agromyza</i> sp. (Agromyzidae) <i>Lonchoptera</i> sp. (Lonchopteridae)	Leaf miner/several vegetables and weeds
<i>C. reburra</i>	unknown	
<i>C. tryphera</i> ²	<i>Brachydeutera argentata</i> (Walker) (Ephydriidae) <i>Oscinella frit</i> (Linnaeus) (Chloropidae) <i>Paregle cinerella</i> (Fallén) (Anthomyiidae) <i>Drosophila</i> sp. (Drosophilidae)	Feeds on organic debris in temporary puddles Stem and seed miner/grasses and small grains Associated with bovine dung
<i>C. vulgaris</i> ³	<i>Phytomyza crassisetata</i> Zett. (Agromyzidae) <i>P. ilicis</i> Curtis <i>Chromatomyia horticola</i> (Goureau) (Agromyzidae) <i>C. nigra</i> (Meigen) <i>Cerodontha caricicola</i> (Hering) (Agromyzidae) <i>Agromyza</i> sp. (Agromyzidae) <i>Opomyza florum</i> (F.) (Opomyzidae) <i>Oscinella frit</i> (Linnaeus) (Cecidomyiidae) <i>Lonchoptera</i> sp. (Lonchopteridae) Chloropidae sp. (Chloropidae)	Leaf miner/ <i>Vernonia officinalis</i> Linnaeus Leaf miner/ <i>Ilex aquifolium</i> Linnaeus Leaf miner/ <i>Aster</i> spp. Leaf miner/ <i>Chrysanthemum</i> and <i>Gazania</i> Leaf miner/ <i>Carex</i> spp. / <i>Lupinus</i> sp. Shoot and stem miner/grasses and small grains Stem and seed miner/grasses and small grains Associated with decaying plant material

Biological references. 1. Askew (1965), Graham (1969), Fulmek (1962), Henriksen (1919). 2. Burks (1979), Blume (1986), Simmonds (1952). 3. Askew (1965), Graham (1969), Henriksen (1919), Nikol'skaya (1952), Peck (1963), von Rosen (1964).

- tibia and tarsus black, pretarsus expanded (Fig. 16). Maxillary palps globularly enlarged
 *vulgaris* Walker
- Males with scutellum coriaceous. Notauli distinct to hind margin of mesoscutum. Mid tibia and tarsus concolorous with fore and hind tibiae and tarsi, middle pretarsus as wide as tarsal segments 1–4 (as in *C. tryphera*, Fig. 15). Maxillary palps slender, segments cylindrical. (Female unknown.) *anapodis*, n. sp.
3. Dorsum of mesosoma flat, scutellum flat between pairs of lateral setae ... *britteni* Askew
- Dorsum of mesosoma convex, particularly the part of the scutellum between the pairs of lateral setae 4
4. Hind margin of T1 with parabolic emargination extending half length of T1 (Fig. 9). Basal cell and vein glabrous. Large species (length 2.2–3.0 mm *capitanea*, n. sp.
- Hind margin of T1 straight mesally or with concavity extending less than a third maximum length of T1 (Fig. 13). Basal vein and cell setate. Smaller species (< 2.2 mm in length) 5
5. Fore wing lacking speculum. Male maxilla with terminal segment of palp lost and with an additional globular expansion off stipites (Fig. 7) *clavicornis* Walker
- Fore wing with speculum (Figs. 10, 12, and 14). Male maxilla with the slender terminal segment of palp visible extending from globularly expanded third segment (Fig. 5) ... 6
6. Fore wing with basal cell entirely setate (Fig. 12). Eye with numerous short erect setae (Fig. 11) *reburra*, n. sp.
- Fore wing with basal half of basal cell bare (Fig. 14). Eye bare *tryphera* Walker

Cyrtogaster anapodis, new species

Description. Holotype Male. Color: Head, mesosoma, petiole, gaster blue-green, frons more green, occiput and neck dark blue. Antenna with scape brownish yellow, pedicel yellowish brown, flagellum brown. Legs with coxae brown and only weakly metallic, pretarsi brown, remainder of leg brownish yellow. Wing veins smoky yellow.

Sculpture: Clypeus smooth, head weakly alveolate, mesoscutum alveolate, scutellum coriaceous, frenum weakly alveolate, dorsellum with some irregular sculpturing medially, propodeum rugose and subalveolate between rugae, gaster smooth.

Structure: Body length 1.3 mm. Head broadly ovate in anterior view, width 1.2 × height (26:21), 2.0 × length (26:13); genal concavity extending about 1/3 malar distance (2.0:5.5); eye bare, height 1.3 × length (12:9), 2.2 × malar distance (12.0:5.5), length 3.0 × temple length (9:3); vertex with transverse carina one ocellar diameter behind lateral ocelli, occiput dropping abruptly behind carina; ratio of MOD, OOL, POL, LOL as 2:4:6:3; torulus on LOcL. Antenna with length of pedicel plus flagellum 1.6 × head width (41:26); ratio of lengths of scape, pedicel, annelli, F1–6, club as 13.0:4.0:1.0:4.5:4.5:4.0:4.5:4.5:3.5:10.5; ratio of widths of F1, F6, club as 2:2:2; annelli annular, transverse; MPP sensillae sparse, two or three visible at a time on each funicular segment. Maxillary palp slender, unexpanded. Mesosoma length 1.8 × width (35:20); notauli distinct to hind margin of mesoscutum; propodeum with spiracles circular, one diameter from anterior margin of propodeum. Wing length 2.4 × width (70:29); ratio of lengths of submarginal, marginal, postmarginal, stigmal veins as 24:14:15:8; basal vein with single row of five setae with one on the cubital vein; basal cell with two setae; speculum open posteriorly. Legs with middle pretarsus slender, cylindrical. Petiole length 1.2 × width (5:4); lacking lateral setae. Gaster ovate, truncate posteriorly; length 1.6 × width (24:15); T1 shallowly concave, median length 0.92 × maximum length (16.5:18.0).

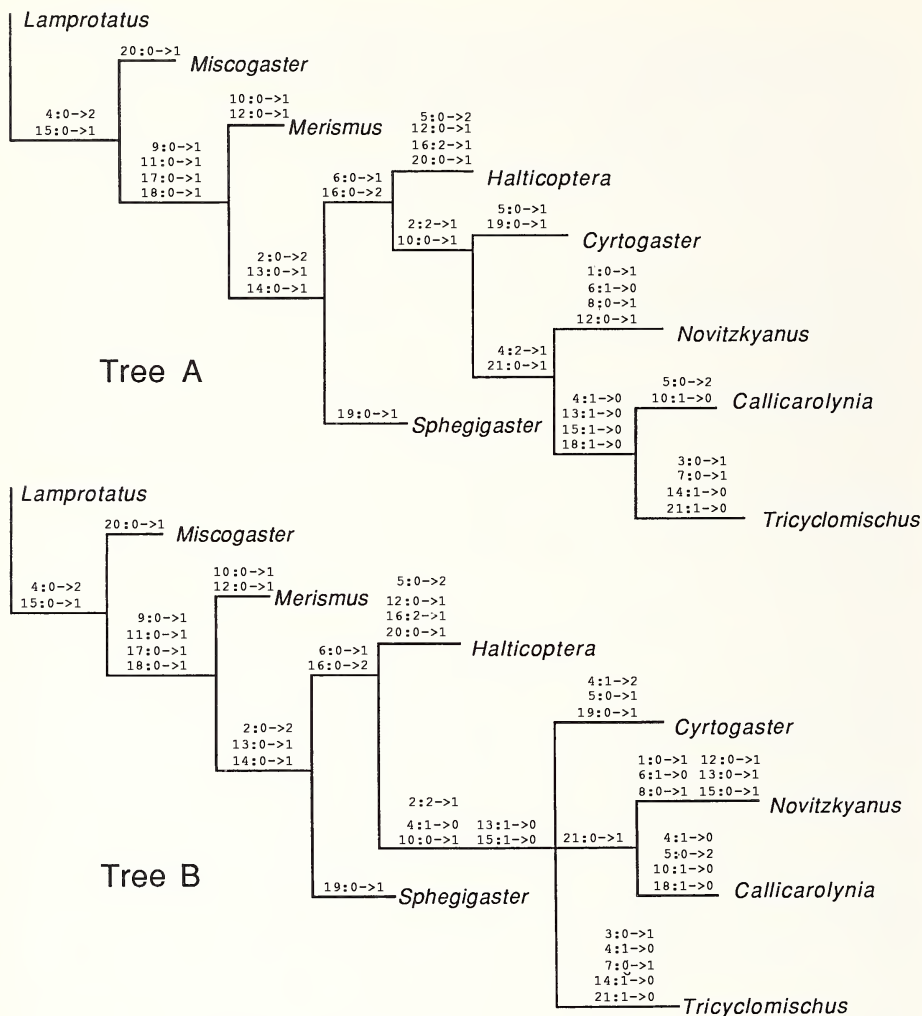
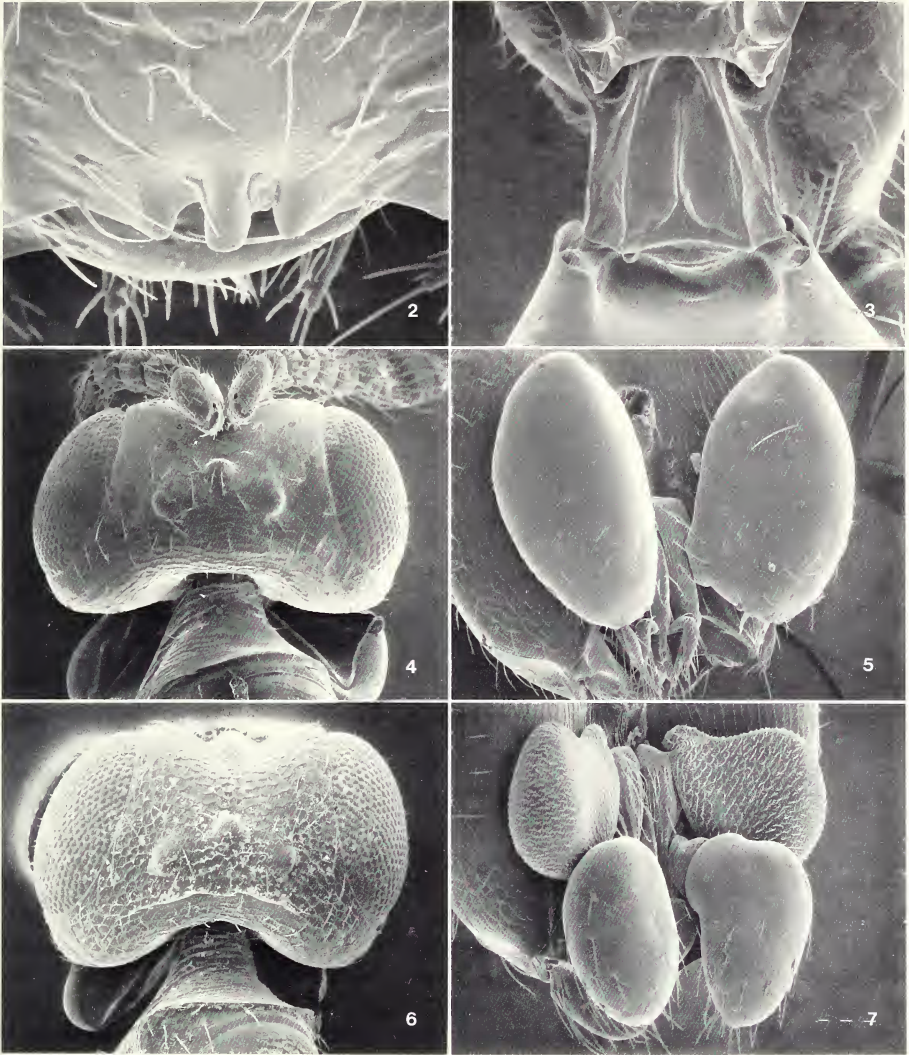


Fig. 1. Cladograms. Tree A. PAUP cladogram derived from character matrix in Table 2. Tree B. Intuitive cladogram input into PAUP showing the optimized character states that resulted. [Character number : state in immediate ancestor → state in immediate descendent.]

Female unknown.

Variation. The body color of the paratype male is green with bronzy reflections on the dorsum of the mesosoma. Its propodeum is finely but distinctly alveolate between the rugae. Its body length is 1.5 mm. The length of the pedicel plus flagellum is 1.5× the head width. The median length of T1 is $\frac{5}{6}$ the maximum length (15:18).

Discussion. *Cyrtogaster anapodisis* differs from other known species of *Cyrtogaster* because it lacks the globularly enlarged male maxillary palps. In my opinion, this



Figs. 2-7. *Cyrtogaster tryphera*. 2. Male clypeus. 3. Male petiole. 4. Male vertex. 5. Male maxillary palps. *Cyrtogaster vulgaris*. 6. Male vertex. *Cyrtogaster clavicornis*. 7. Male maxillary palps.

characteristic is a reversion to the ancestral state because this species otherwise resembles *C. vulgaris*, the most morphologically advanced species in the genus. Both species have a carinate vertex and similar sculpturing on the propodeum and petiole, but can be distinguished from each other by the characters given in the key. In addition, the flagellum is brown in *C. anapodisis*, and yellow in *C. vulgaris*. Further, in males of *C. anapodisis*, the length of the pedicel plus flagellum is 1.5-1.6 times

the head width, in males of *C. vulgaris*, it is about as long as the head width. Though the female of *C. anapodisis* is unknown, it is likely to have a carinate vertex like that of the males and therefore would run out to couplet 2 in the key. The same differences in the development of the notauli and in the sculpturing of the scutellum given there for distinguishing the males of these two species are likely to distinguish the females as well.

Etymology. The species name, from the Greek word *anapodisis* meaning a going back, refers to the reversion to slender maxillary palps in males.

Type material. The holotype male and one paratype male (both INHS) were collected in Colorado at Green Mountain Falls (Teller County) on 17 July 1938 by H. H. Ross.

Cyrtogaster britteni Askew

Cyrtogaster britteni Askew, 1965:180-182, 184; Graham, 1969:142, 143; Askew, 1975:16; Dzhanokmen, 1978:81.

The type of *C. britteni* was not in the collection at Oxford as reported in Askew (1975). The Nearctic specimens compare rather exactly with the description by Askew.

Discussion. This species is easily recognized by the flattened dorsum of the mesosoma. A tiny straight edge laid along the median longitudinal line of the mesosoma would contact the following structures simultaneously: the posterior portion of the mesoscutum, the entire scutellum, the dorsellum, and sometimes the transverse carina along the anterior margin of the propodeum.

In *C. reburra*, the scutellum is fairly flat between the rows of lateral setae but the mesosoma is continuously curved anterioposteriorly so that the surface of the dorsellum is not coplanar with that portion of the scutellum anterior to the frenal sulcus. In addition, the female antenna of *C. reburra* has F1 distinctly transverse, and the length of the pedicel and flagellum is 0.75 and 0.80 times the head width in the two known female specimens. The F1 in female *C. britteni* is about as long as wide, and the combined length of the pedicel plus the flagellum varies between 0.87 and 0.92 times the head width in the Nearctic female specimens. The distributions of the two species are also highly disparate, with *C. britteni* known from northeastern Canada, and *C. reburra* from west-central United States.

Distribution. *Cyrtogaster britteni* was described from England (Askew, 1965) but has not yet been reported from continental Europe. In the Nearctic region, it has been collected from two sites around Hudson Bay and one around Ungava Bay (all CNC). CANADA. MANITOBA: Churchill, 5-VIII-1952, 1♀; Warkworth Creek (near Churchill), 21-VI-1952, 1♀. ONTARIO: Moose Factory, 27-VIII-1959, 1♀. QUEBEC: [Fort] Chimo, 17-18-VIII-1959, 3♀.

Biology. Nothing is known of the host(s) of this species.

Cyrtogaster capitanea, new species

Figs. 8-10

Description. Holotype Female. Color: Head, mesosoma, coxae, petiole dark green with strong purplish reflections; gaster black with greenish reflections. Antenna with scape yellow-brown, pedicel brown with weak metallic green reflections, remainder

of flagellum black. Mandible yellow, teeth reddish. Legs yellow-brown; pretarsi brown. Wing veins translucent brown, stigma distinctly darker.

Sculpture: Head with clypeus smooth; face coriaceous; frons alveolate medially, more imbricate dorsolaterally; mesoscutum alveolate, side lobes weakly alveolate; scutellum alveolate; dorsellum rugulose; propodeum smooth, median panels with rugae; petiole subreticulate with numerous longitudinal carinae laterally; gaster smooth.

Structure: Body length 2.3 mm. Head subtriangular in anterior view, width $1.2 \times$ height (36:31), $1.8 \times$ length (36:20); genal concavity extending almost $\frac{1}{3}$ malar distance (4:11); eye with scattered short erect setae, eye height $1.4 \times$ length (19:14), $1.7 \times$ malar distance (19:11), length $2.5 \times$ temple length (14.0:5.5); ratio of MOD, OOL, POL, LOL as 2.0:6.0:7.0:3.5; vertex acarinate, rounding smoothly into occiput; torulus with upper edge on LOCL. Antenna with length of pedicel plus flagellum $1.1 \times$ head width (38:36); ratio of lengths of scape, pedicel, annelli, F1–6, club as 21.0:6.0:3.0:4.0:3.5:4.0:4.0:3.5:7.0; ratio of widths of F1, F6, club as 3.5:5.0:5.0; both annelli quadrate; three to seven MPP sensillae visible at a time on each funicular segment. Mesosoma length $1.7 \times$ width (49:29); notauli obscure posteriorly, demarcated as line of distinct texture and color; scutellum with frenum obscure; propodeum with spiracles oval, placed on anterior edge of propodeum. Fore wing length $2.6 \times$ width (79:30); ratio of lengths of submarginal, marginal, postmarginal, stigmal veins as 33:15:10:7; basal cell and vein bare; speculum open posteriorly. Petiole length $1.3 \times$ width (9.5:7.5); one pair of lateral setae anteriorly. Gaster ovate, length $1.6 \times$ width (45:28); T1 with parabolic emargination reaching half way to base, median length of T1 $0.53 \times$ maximum length (18:34).

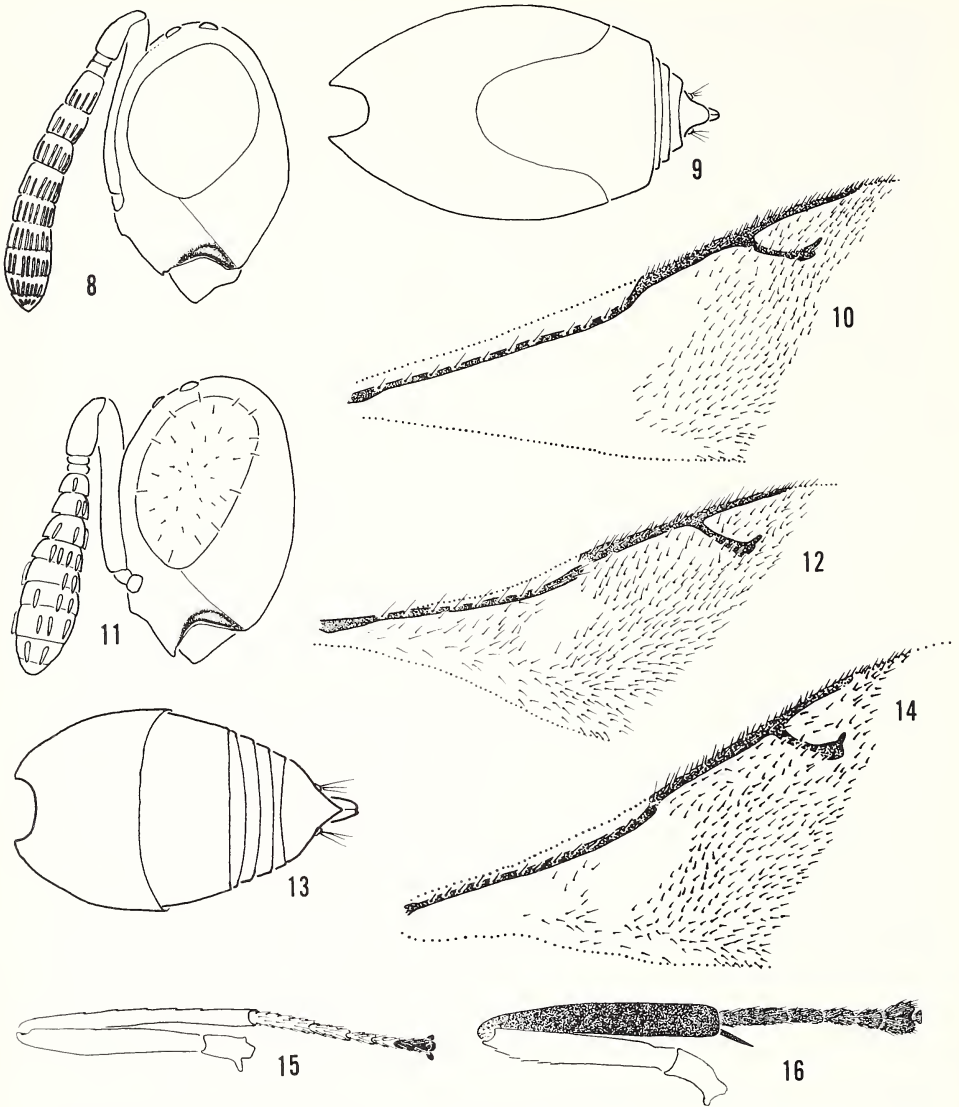
Allotype male. Color: Body color green with weak coppery reflections along dorsum; antennal flagellum brown. **Structure:** Body length 2.3 mm. Antenna with flagellum $1.6 \times$ as long as head width (43:27); ratio of lengths of scape, pedicel, annelli, F1–6, club as 23.0:5.0:4.0:4.5:4.5:4.0:4.0:3.5:3.5:10.5; widths of F1, F6, club as 3.5:4.0:4.0. Maxillary palp metallic green, third segment globularly enlarged, terminal segment needlelike. Legs with middle pretarsus cylindrical. Petiole length $1.7 \times$ width (12:7). Gaster ovate, length $1.4 \times$ width (36:25).

Variation. Female body length varies between 2.5 and 2.7 mm, and male body length varies between 2.2 and 2.9 mm. Specimens from the Rocky Mountain region often have a diffuse brown patch of pigment in the fore wing just behind the stigma. The scutellum is sometimes more reticulate and the dorsellum smooth. The color of the males varies from yellow-green to blue-green, and their flagellum is sometimes brown.

Discussion. This species is easily recognized by its relatively large body size. The smallest male examined was 2.2 mm long, a length attained among the other species only by the largest *C. vulgaris* females. Other unique characters of this species are the glabrous basal cell and vein and the hind margin of T1, which is emarginate half way to its base. This species and *C. vulgaris* both have elongate petioles and notauli that are shallow posteriorly.

Etymology. The species name, from the Latin *capitaneus* meaning chief in size or large, refers to the relatively large size of the individuals of this species compared with individuals of other species in the genus.

Type material. The holotype female (USNM) is from O'Sullivan Dam, Grant County, Washington, and was collected on 22 July 1954 by M. T. James. The allotype male (USNM) is from Midland County, Michigan, and was collected on 28 June



Figs. 8-16. *Cyrtogaster capitanea*. 8. Female head, lateral view. 9. Female gaster, dorsal view. 10. Female fore wing. *Cyrtogaster reburra*. 11. Female head, lateral view. 12. Female fore wing. 13. Female gaster, dorsal view. *Cyrtogaster tryphera*. 14. Female fore wing. 15. Male middle leg. *Cyrtogaster vulgaris*. 16. Male middle leg.

1953 by R. R. Driesbach. Sixteen paratypes are distributed as follows (CNC, CSU, INHS, SEC, USNM, UW): Canada. NORTHWEST TERRITORIES: Yellowknife, 5-VI-1953, ♀. ONTARIO: James Bay, 23-28-VIII-1976, 2♂. United States. COLORADO: Fort Collins, 17-VII-1985, 1♂. IDAHO: Parma, 14-XI-1935, ♀; Tuttle Co., 1-VII-1949 (on *Salsola pestifer* Nelson), ♀. ILLINOIS: Algonquin, 15-VII-1984, ♀.

INDIANA: 1♂. MICHIGAN: Calhoun Co., 4-IX-1958, 1♂; Cheboygen Co., 13-VIII-1942, 1♂, Midland Co. 28-VI-1958, 1♂. NEW MEXICO: La Joya Wildlife Preserve, 20 mi. N Socorro, 15·25-VII-1976, 1♀; Ruidoso, 26-VI-1940, 1♀; Rio Grande, 6-VII-1953, 1♀. VIRGINIA: Winchester, 13-VI-1964, 1♀. WISCONSIN: Dane Co., VI-1946, 1♂; Dunn Co., 29-VII-1949 (on *Ulmus americanus*), 1♀.

Biology. Nothing is known of the host(s) of this species.

Cyrtogaster clavicornis Walker

Fig. 7

Cyrtogaster clavicornis Walker, 1833:383; Delucchi, 1955:175; Graham, 1956:261; Graham, 1969:144.

Cyrtogaster obscura Walker, 1833:383; Delucchi, 1955:175; Graham, 1956:261; Graham, 1969:144.

Polycystus matthewsii Westwood, 1839:68; Graham, 1956:261; Graham, 1969:144.

Polycystus scapularis Thomson, 1878:26; Henriksen, 1919:164-165; Graham, 1956:261; Burghelle, 1959:124.

Polycystus clavicornis (Walker): Graham, 1956:261; Fulmek, 1962:33, 44; Askew, 1965:183-184; Graham, 1969:144; Dzhankmen, 1978:80; Graham, 1979:276.

The lectotype of *C. clavicornis* (BMNH Hym. Type No. 5.1816) was examined. The rest of the synonymy is accepted as given by Graham (1969).

Discussion. In the USNM collection, there is a single male specimen, collected 22 June 1953 from Cherry Creek in Pinos Altos, New Mexico, which differs in no immediately discernible way from males of *Cyrtogaster clavicornis* from Burnham Beeches Park, England, in my own collection. Perhaps as more Nearctic specimens are collected, especially females, differences with the Palearctic material will be discovered.

Biology. Known hosts of *C. clavicornis* in Europe are listed in Table 3. The biology of this species should make a very interesting study because of the strong aquatic associations of its known hosts. Two of its hosts, ephydriids of the genus *Hydrellia* (Graham, 1969), are miners of plants in aquatic habitats. *Hydrellia griseola* (Fallén) larvae form blotch mines either above or below the surface of the water in over 40 genera of Gramineae and 20 non-gramineous plants (Deonier, 1971). Burghelle (1959) reared *Cyrtogaster clavicornis* in large numbers from *Hydrellia griseola* pupae collected in mid-winter from puddles formed in the cracks in the bottoms of shallow ponds. He observed the wasps emerging from the puparia and moving in the water until they found a hold on which to crawl out of the water. Another host, *H. nasturtii* Collin, the watercress stem miner, is a pest of watercress (*Nasturtium officinale* L.) in England (Taylor, 1928). Watercress is a sprawling perennial that grows in shall water. Its stems are often partly submerged. The developmental stage in which *Cyrtogaster clavicornis* attacks its hosts and whether it can attack them below the surface of the water are unknown.

Cyrtogaster reburra, new species

Figs. 11-13

Description. Holotype Female. Color: Head, mesosoma, coxae, petiole dark green; gaster black; remainder of legs brown, lighter at "knees" and near apex of middle tibia. Antenna with scape, pedicel dark green; flagellum dark brown. Wing veins pale

brown, stigma darker, basal half of submarginal vein lighter, apical tip of submarginal vein just before junction with marginal vein colorless.

Sculpture: Head, mesonotum subalveolate except clypeus smooth and face coriaceous; scutellum coriaceous, cells of frenum longer than wide; propodeum granulate-rugose; petiole granulate; gaster smooth, granulate basolaterally.

Structure: Body length 1.5 mm. Head ovate in anterior view, width $1.2 \times$ height (23.5:20.5), $2.0 \times$ length (23.5:12.5); genal concavity extending $\frac{1}{4}$ malar distance (1.5:6.5); eye setate, height $1.3 \times$ length (11.0:8.5), $1.7 \times$ malar length (11.0:6.5), length $3.4 \times$ temple length (8.5:2.5); vertex acarinate, rounding smoothly into occiput; ratio of MOD, OOL, POL, LOL as 1.5:3.5:6.0:3.0; torulus located just below LOcL. Antenna with length of pedicel plus flagellum $0.81 \times$ head width (19.0:23.5); ratio of lengths of scape, pedicel, annelli, F1-6, club as 11.0:4.0:1.0:1.5:1.5:1.5:1.5:1.5:5.0, ratio of widths of F1, F6, club as 2:4:4; annelli annulate, transverse; MPP sensillae sparse, only one or two visible at one time on F1-4. Mesosoma length $1.6 \times$ width (34:21); notauli groovelike; propodeum with spiracles circular, located one inner diameter from anterior margin of propodeum. Fore wing length $2.5 \times$ width (64.0:25.5); ratio of lengths of submarginal, marginal, postmarginal, stigmal veins as 24.5:11.5:7.0:6.0; basal cell completely setate; speculum reduced, closed by several rows of setae posteriorly. Petiole length $0.5 \times$ width (4:8), with no lateral setae. Gaster ovate; length $1.5 \times$ width (32:22); median length of T1 $0.84 \times$ its maximum length (12:14).

Allotype male. Color is similar to holotype except scape yellow-brown, flagellum brown, legs with color pattern like female but paler. Sculpture like that of holotype. Structure: Body length 1.4 mm. Antenna with length of pedicel plus flagellum $0.96 \times$ head width (24:25); ratio of lengths of scape, pedicel, annelli, F1-6, club as 13.5:4.5:1.0:2.0:2.0:2.0:2.0:2.0:7.0, widths of F1, F6, club as 2.0:2.5:3.0. Maxillary palps with third segment metallic green and globularly enlarged, terminal segment fusiform, slender. Legs with middle pretarsus cylindrical. Petiole length $0.5 \times$ width (4:8). Gaster parabolic in shape, length $0.83 \times$ width (19:23).

Variation. Body length measured 1.5 and 1.6 mm for females; all males were 1.4 mm in length. The five known specimens are from the same rearing, and little morphological variation is found among them.

Discussion. *Cyrtogaster reburra* is readily distinguished by its small body size, a female antenna that is short (length of pedicel and flagellum of females measured 0.75 and $0.80 \times$ head width) and clavate (F1 is half the width of F6), distinctly setate eyes, and a completely setate basal cell.

Etymology. The species name, from the Latin *reburrus* meaning one with bristling hair, refers to the short, erect setae on the eyes that are characteristic of this species.

Type material. The holotype female, allotype male, and 1 female and 2 male paratypes (all USNM) were collected on an animal carcass on the Bear River, Box Elder County, Utah, on 20-VII-1982 by S. W. Skinner.

Biology. Nothing is known of the hosts of this species, but the type series was taken on an animal carcass.

Cyrtogaster tryphera (Walker)

Figs. 2-5, 14, 15

Lamprotatus trypherus Walker, 1843:158 (Lectotype, BMNH Hym. Type No. 5.821; examined); Walker, 1846:32; Burks, 1975:161.

Cyrtogaster glasgowi Crawford, 1914:36–37 (Holotype, USNM Type No. 18241; examined); Simmonds, 1952:525–528 (biology); Peck, 1963:626; Askew, 1965:179, 182–183, 184, 186; Graham, 1969:142, 143–144; Askew, 1975:16.
Cyrtogaster tryphera: Burks, 1975:161–162; Burks, 1979:787; Blume, 1986:216–217 (biology).

Discussion. *Cyrtogaster tryphera* is rather difficult to characterize since it lacks the apomorphic characteristics that make each of the other *Cyrtogaster* species distinctive. The redescription of *C. tryphera* (as *C. glasgowi*) by Askew (1965) was based on a single specimen and should be corrected or supplemented as follows. The body length of females varies between 2.1 and 1.3 mm. The body size may depend on the size of the host since a series of nine females reared on *Oscinella frit* (L.) are all close to 1.8 mm in length. Body color is generally very dark green, not black as stated. Head height $1.2 \pm (\text{SE})0.01 \times \text{width}$ ($N = 10$), width $1.9 \pm 0.00 \times \text{length}$; eye glabrous, height $1.7 \pm 0.04 \times \text{malar distance}$; ratio of OOL, POL, LOL as $6.2 \pm 0.19:3.8 \pm 0.08:3.4 \pm 0.15$; torulus located just below LOcL. Antenna with length of pedicel plus flagellum $1.0 \pm 0.02 \times \text{head width}$; ratio of lengths of scape, pedicel, F1–6, club as $12 \pm 0.28:3.7 \pm 0.20:1.6 \pm 0.12:1.9 \pm 0.11:2.0 \pm 0.14:2.1 \pm 0.11:2.1 \pm 0.12:1.9 \pm 0.12:5.8 \pm 0.16$; ratio of widths of F1, F6, club as $2.1 \pm 0.12:3.4 \pm 0.13:3.7 \pm 0.14$. Propodeal sculpture variable, ranging from generally cobbled in appearance with weak rugae to nearly smooth with strong rugae. Fore wing length $2.4 \pm 0.03 \times \text{width}$; ratio of lengths of marginal, postmarginal, stigmal veins as $13 \pm 0.60:6.6 \pm 0.34:5.6 \pm 0.22$; speculum open posteriorly. Petiole length $0.88 \pm 0.034 \times \text{width}$; no lateral setae present. Gaster $1.8 \pm 0.05 \times \text{as long as wide}$; T1 with median emargination extending about a quarter of its median length.

Males generally paler in color than females, green to dark green with legs brownish yellow. Body length of males varies between 2.0 and 0.92 mm. Antenna with length of flagellum plus pedicel $1.1 \pm 0.01 \times \text{head width}$ ($N = 5$); ratio of lengths of scape, pedicel, F1–6, club as $8.6 \pm 1.1:2.8 \pm 0.49:1.5 \pm 0.16:1.6 \pm 0.19:1.6 \pm 0.32:1.6 \pm 0.20:1.6 \pm 0.29:1.4 \pm 0.25:5.2 \pm 0.76$; widths of F1, F6, club as $1.5 \pm 0.16:2.0 \pm 0.17:2.1 \pm 0.17$. Maxillary palp with only third segment globularly expanded, terminal segment very slender, fusiform.

Distribution. *Cyrtogaster tryphera* is by far the most common Nearctic *Cyrtogaster* species and probably occurs throughout North America. It has been collected from the following U.S. states and Canadian provinces and territories (CNC, CU, INHS, SEC, UCR, USNM, UW): Arizona, California, Delaware, Florida, Georgia, Illinois, Kansas, Kentucky, Michigan, Minnesota, Missouri, New Jersey, New York, South Dakota, Texas, Virginia, Wisconsin, British Columbia, Northwest Territories, Ontario, Quebec, and Yukon Territory.

Biology. Simmonds (1952) studied the biology of *C. tryphera* with specimens obtained from wheat stems heavily infested by *Oscinella frit*, but also infested by some chloropids and the Hessian fly. He has found that specimens could be readily reared on *O. frit* puparia in the laboratory. Simmonds gave a description of the egg that is very similar to one given by Cameron (1939) for *Cyrtogaster vulgaris*. Simmonds reported that the egg is usually laid in a furrow on the pupa and that only one egg is laid per host. An individual female may lay as many as 150 eggs during her lifetime. At 24°C, eggs take 24 hours to hatch. The first instar lasts 2–3 days, the second and third instar each take 2 days, a prepupal stage lasts one day, and the

pupal instar lasts six days. Females mate only once, and in laboratory situations, mating often occurs immediately upon emergence of the female. Females may live more than a month; males live only about 10 days. Recorded hosts are listed in Table 3. Adult *C. tryphera* have been taken in the months of February and March, a finding that suggests adults overwinter. I have collected adults by sweeping in Illinois from 19 May through 1 November.

Cyrtogaster vulgaris Walker

Figs. 6, 16

Cyrtogaster vulgaris Walker, 1833:382; Reinhard, 1859:192; C. G. Thomson, 1878: 25; Ashmead, 1894:55–56; Dalla Torre, 1898:168; Lameere, 1907:233; Schmiedeknecht, 1909:383; Grimshaw, 1915:349; Henriksen, 1919:164; Baird, 1938:87, 132, 140; Baird, 1939:106, 120, 124; Cameron, 1939:178–180, 197–199; Baird, 1940:99, 116, 121; Downes and Andison, 1940:948; McLeod, 1951:33; Simmonds, 1952:525 (biology); Nikol'skaya, 1952:252; Baird and McLeod, 1953:234; McLeod, 1954:22–23; Delucchi, 1955:174, 175 (synonymy); W. R. Thomson, 1958: 591 (biology); Delucchi, 1962b:14; Peck, 1963:627; Peck et al., 1964:38; von Rosen, 1964:[not seen, cited in Askew (1965)]; Askew, 1965:179–180, 181, 183, 184, 185–186 (biology, synonymy); Graham, 1969:142–143 (synonymy); Askew, 1975:14, 15–16; Jones, 1976:91, 99, 100; Boucek, 1977:34; Dzhanakmen, 1978:80; Norlander, 1978:89–90; Graham, 1979:276 (distribution); Hedqvist, 1983:167.

Cyrtogaster scotia Walker, 1833:382–383; Askew, 1965:179–180 (synonymy); [But see Graham, 1969:143, 202.]

Cyrtogaster thoracica Walker, 1833:382; Delucchi, 1955:174; Graham, 1969:142.

Cyrtogaster rufipes Walker, 1833:383; Westwood, 1839:68; Grimshaw, 1915:349; Delucchi, 1955:174; Graham, 1969:142.

Cyrtogaster tenuis Walker, 1833:384; Askew, 1965:179–180; Graham, 1969:143.

Cyrtogaster cingulipes Walker, 1833:384; Delucchi, 1955:174; Graham, 1969:143.

Dicormus aquisgranensis Förster, 1840:38; Delucchi, 1955:174–175; Graham, 1969: 143.

Cyrtogaster poesos Walker, 1848:107, 164; Graham, 1969:142, 143.

Lamprotatus acarnas Walker, 1848:111, 168; Graham, 1969:142, 143.

Cyrtogaster biglobus Förster, 1861:33. Delucchi, 1955:174; Graham, 1969:142, 143.

Sphegigaster deneger Walker, 1872:117; Graham, 1969:142, 143.

The lectotypes of *C. vulgaris*, *C. rufipes*, and *C. thoracica* (in the main collection of the BMNH) were examined. The remainder of the synonymy is accepted as given by Graham (1969).

Discussion. *Cyrtogaster vulgaris* is easily recognizable because it and *C. anapodisis* are the only Nearctic species with a transverse carina on the vertex just posterior to the ocelli. The two species are readily separated by the characters given in the discussion section for *C. anapodisis*. The notauli are rather weak posteriorly in *C. vulgaris* and *C. capitanea*. The males are readily distinguished from those of other Nearctic species by having the terminal segment of the maxillary palp clavate, the middle tarsi much darker than the fore and hind tarsi, and the middle basitarsus expanded and subcordiform.

Distribution. *Cyrtogaster vulgaris* is widespread throughout the Palearctic (Graham, 1969) and occurs as far south as Morocco (Delucchi, 1962b). Although said to be

introduced into British Columbia in 1937 (Baird, 1938), it was already present in the Nearctic. A female in the CNC was collected in 1931 from Vernon, British Columbia, and a male from South Bristol, Maine, was collected in 1933. This species may have been accidentally introduced into North America earlier because it has been intercepted at ports of entry into the United States on at least five separate occasions. *Cyrtogaster vulgaris* has been collected from the following U.S. states and Canadian provinces and territories (CMNH, CNC, INHS, UBC, UCD, UCR, UW, USNM): Alaska, California, Illinois, Maine, Michigan, Oregon, Pennsylvania, Wisconsin, British Columbia, Labrador, New Brunswick, Newfoundland, Nova Scotia, Ontario, Quebec, and Yukon Territory.

Biology. Known hosts of this species are given in Table 3. In addition, this species has been collected on or associated with the following plants in North America: *Malus pumila* Mill, *Pisum sativum* L., *Senecio jacobaea* L., *Vicia angustifolia* L., *Vicia* sp., and leaf miners on *Brassica*, *Papaver*, *Picea*, and *Primula vulgaris* Hudson.

Cameron (1939) reported that *C. vulgaris* is a solitary primary parasite on the pupal stage of the holly leaf miner, *Phytomyza ilicis*, and that the biology of *C. vulgaris* closely resembles that of *Sphégigaster flavicornis* [= *pallicornis* (Spinola)], which he said is an external parasite within the puparium of the fly and goes through five larval instars. He also noted that adult *C. vulgaris* have a singularly effective habit of feigning death. Females of this species overwinter in a variety of coarse or tufted plant material (Askew, 1965; Graham, 1969; VanderSar, 1978). These females have no eggs in their ovaries during the winter, but are fertile and can resume egg laying the following spring (Askew, 1965; Cameron, 1939).

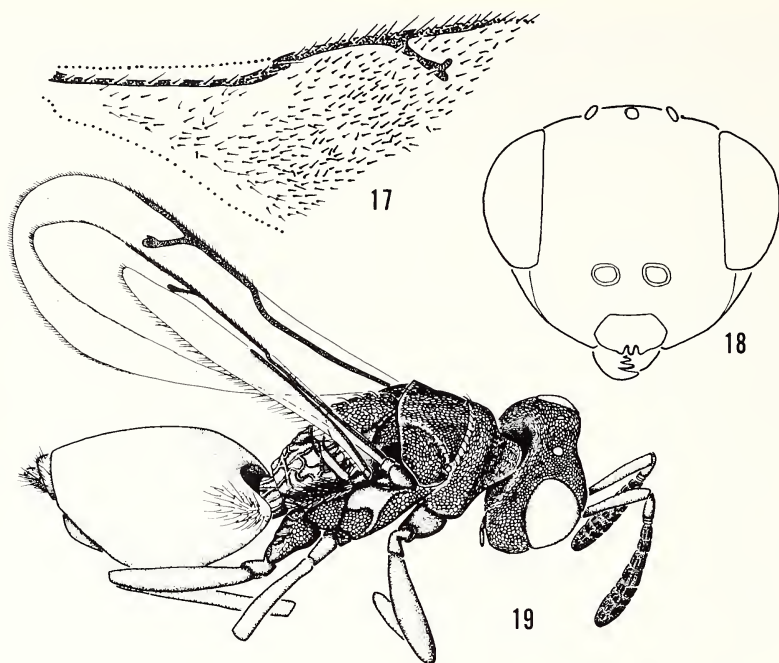
Cyrtogaster annectens, new species

Fig. 17

Description. Holotype Male. Color: Head, mesosoma, coxae, petiole, gaster dark green, frons with strong yellowish reflections. Antenna with basal third of scape yellowish brown; remainder, pedicel brownish green; flagellum reddish brown. Legs brownish yellow; pretarsi black. Wings with submarginal vein and stigma pale brown; marginal, postmarginal, stigmal veins pale yellow-brown.

Sculpture: Clypeus smooth; head coriaceous, more coarse around torulus; mesoscutum coriaceous, weakly alveolate medially; scutellum coriaceous; propodeum smooth, rugose medially; petiole smooth; gaster smooth.

Structure: Body length 1.6 mm. Head ovate in anterior view, width $1.3 \times$ height (28:22), $1.8 \times$ length (28:16); genal concavity extending half malar distance (3:6); eye glabrous, height $1.3 \times$ length (13:10), $2.2 \times$ malar distance (13:6), length $2.9 \times$ temple length (10:3.5); vertex acarinate, ratio of MOD, OOL, POL, LOL as 2:5:8:3.5; torulus located $1 \times$ own diameter above LOCL. Antenna with length of flagellum plus pedicel $1.2 \times$ head width (33:28); ratio of lengths of scape, pedicel, annelli, F1–6, club as 14.0:4.0:1.5:2.5:3.5:3.5:3.5:3.0:3.0:10.0; width of F1, F6, club as 2:2:2; annelli annulate, transverse; 1–2 MPP sensillae visible at a time on each funicular segment. Maxillary palp with terminal segment and stipites enlarged. Mesosoma length $1.7 \times$ width (38:23); notauli complete as row of elongate punctures; dorsellum carinate anteriorly; propodeum with spiracles circular, placed on anterior margin of propodeum. Fore wing length $2.4 \times$ width (72:30); ratio of lengths of submarginal, marginal, postmarginal, stigmal veins as 27:15:9:7; basal cell with anterior row of setae, 3



Figs. 17–19. *Cyrtogaster annectens*. 17. Male fore wing. *Callicarolyntia eruga*. 18. Female head, anterior view. 19. Female habitus, dorsolateral view.

irregular rows down basal vein; cubital vein setate; speculum reduced, closed posteriorly. Legs with pretarsi cylindrical. Petiole length $0.75 \times$ width (4.5:6.0); with no lateral setae. Gaster ovate, truncate apically; length $1.1 \times$ width (22:20); T1 with median length $0.81 \times$ maximum length (12.5:15.5).

Allotype female. Color similar to holotype except head blue laterally. Sculpture similar to holotype. Structure: Body length 2.5 mm. Antenna with length of pedicel plus flagellum $0.96 \times$ head width (34.0:35.5); ratio of lengths of scape, pedicel, anelli, F1–6, club as 16.5:5.0:2.0:3.0:3.5:3.5:3.0:3.0:3.0:8.5; width of F1, F6, club as 2:3:4. Petiole length $0.7 \times$ width (5.0:7.5). Gaster cordate, length $1.8 \times$ width (50.0:28.5).

Discussion. *Cyrtogaster annectens* is annectant between *Cyrtogaster* and *Polycystus*. It has the speculum on the fore wing characteristic of *Cyrtogaster* and the male maxillary palp structure characteristic of *Polycystus*. Principally on the basis of these character distributions, I synonymize *Polycystus* with *Cyrtogaster* because females of the two genera are indistinguishable. Aside from the male palpal structure, this species resembles *C. tryphera*. The females can be distinguished by the position of the toruli. In *C. annectens*, the toruli are just above the LOcL; in *C. tryphera*, they are at or below this line.

Etymology. The species name is from the Latin word *annectens*, meaning linking or joining, and refers to the morphologically intermediate structure of this species between the genera *Cyrtogaster* and *Polycystus*.

Type material. The holotype male (USNM) is from Pu'u Hapapa, 4 km SW Wahiawa, O'ahu, Hawaii, and was collected 16 January 1927 by O. H. Swezey. The allotype

female (USNM) is from Kumuweia Ridge, 14 km SW Ha'ena, Kauai, Hawaii, and was reared from a tephritid on *Bidens cosmoides* (A. Gray) Sherff on 19 June 1932 by O. H. Swezey.

Biology. The allotype female was reared from a tephritid on *Bidens cosmoides* (A. Gray) Sherff.

Callicarolynia, new genus

Type species: *Callicarolynia eruga*, n. sp.

Description. Color: Head, mesosoma, coxae, petiole metallic dark green; gaster black.

Female. Head pentagonal in anterior aspect, antennal scrobes deep; clypeus nearly smooth, with three symmetrically arranged marginal denticles; gena without hollow above base of mandible; eye setate; occiput acarinate. Antenna inserted just below LOcL; formula 1:1:2:6:3; scape slender, length approximately $9 \times$ width; flagellum strongly clavate (width of club about $2 \times$ width of F1), finely granulate; MPP sensillae coarse, prominent, in single dense transverse row; club blunt apically, lacking terminal spine or large patch of micropilosity. Mandibles four-toothed. Mesosoma with pronotal collar rounding smoothly over into neck; notaulus complete as deep septate groove; scutellum as long as wide, with four to many pairs of lateral setae, frenal sulcus distinct; propodeum rugose with sculpture between rugae irregular, spiracle shortly ovate, callus with setae relatively dense, nucha undeveloped; mesopleuron with upper epimeron smooth. Legs with two hind tibial spurs. Fore wing with relative lengths of veins as follows: submarginal $>$ marginal $>$ postmarginal $>$ stigmal; basal cell setate; speculum nearly closed posteriorly. Petiole transverse, rather smooth except for median, diverging sublateral, and lateral carinae; basal ventral flange present; without lateral setae. Gaster ovate; T1 covering nearly its entire dorsal surface, hind margin straight.

Male. Similar to female except flagellum parallel-sided and MPP sensillae less prominent. Maxillary palp with terminal segment somewhat enlarged as a weak-walled yellow sack.

Discussion. *Callicarolynia* is distinguished from the other genera in the *Cyrtogaster*-group by the characters given in Table 1. *Callicarolynia* would key out to *Syntomopus* Walker in Graham (1969), but can be distinguished from that genus by having the dorsum of the mesosoma arched, T1 nearly covering the entire gaster, and the male maxillary palps lamellately expanded.

Etymology. The generic name is derived from the Latin *calli-*, meaning beautiful, and the name of my wife, Carolyn. The gender is feminine.

Callicarolynia eruga, new species

Figs. 18, 19

Description. Holotype Female. Color: Head, mesosoma, coxae, petiole olive green; face, scape, pedicel green; flagellum, gaster black; legs yellow-brown with some metallic coloration on femora, tarsi paler; mandible reddish brown; maxillary palp brown.

Sculpture: Clypeus smooth; head, scape, mesoscutum alveolate; scutellum, axilla coriaceous; gaster polished.

Structure: Body length 2.0 mm. Head width $1.2 \times$ height (34:28), $2.1 \times$ length (34.0:

16.5); eye with scattered short erect setae, height $1.4 \times$ length (16.0:11.5), $1.6 \times$ malar length (16:10), length $2.9 \times$ temple length (11.5:4.0); ratio of MOD, OOL, POL, LOL as 2.0:5.0:7.0:3.5; torulus located just below LOcL. Antenna with length of flagellum plus pedicel $0.94 \times$ head width (32:34); ratio of lengths of scape, pedicel, annelli, F1-6, club as 18.0:5.0:1.5:3.5:3.5:3.5:3.5:3.0:8.0, ratio of widths of F1, F6, club as 2.5:4.0:4.0. Mesosoma length $1.7 \times$ width (46:27); scutellum with four pairs of lateral setae and one more medial pair between first two pairs; propodeal callus with long dense setae; spiracle length $2 \times$ width, $1.5 \times$ outside diameter from anterior margin of propodeum. Fore wing length $2.7 \times$ width (77:29); ratio of lengths of submarginal, marginal, postmarginal, stigmal veins as 32:15:12:11; costal cell with single complete row of setae; basal cell with distal $\frac{2}{3}$ setate; speculum open posteriorly. Petiole length $0.6 \times$ width (4:7). Gaster length $1.4 \times$ width (41.5:28.5); dense hair patches present laterally on T1.

Allotype male. Color similar to holotype female except head, mesosoma yellow-green with side lobes and hind margin of mid lobe of mesoscutum, scutellum with strong purplish reflections; maxillary palp yellow-brown; T1 dark green basally; legs lacking any metallic coloration, middle tibial spur black. Sculpture. Face imbricate, otherwise similar to the holotype. Structure. Body length 2.0 mm. Antenna inserted just above LOcL; length of flagellum plus pedicel $1.0 \times$ head width (34:34); ratio of lengths of scape, pedicel, annelli, F1-6, club as 18.0:4.5:1.5:3.0:3.5:3.5:3.5:3.0:9.0; widths of F1, F6, club as 3.0:3.5:4.0. Terminal segment of maxillary palps lamellately expanded, length $2.3 \times$ width (7:3). Legs with middle tibia slightly expanded, ventral edge sharp. Petiole length $0.64 \times$ width (4.5:7.0). Gaster length $1.3 \times$ width (31:23).

Variation. The body length of the female types varies from 1.8-2.3 mm. Body color varies from blue-green to olive-green. The base color of the legs varies from pale brownish yellow to pale reddish brown. The dark bands on the femora may or may not have metallic reflections.

Etymology. The specific name is derived from the Latin word *erugo*, meaning clear of wrinkles or smooth, and refers to the rounded pronotal collar.

Type material. The holotype was collected in Mackinac County, Michigan, on 30 August 1959 by R. and K. Driesbach (USNM). The allotype was collected 7 km SW Carleton Place, Ontario, on 11-17 July 1980 by S. J. Miller (CNC). Seven paratypes were collected as follows (CNC, SEC, USNM): Canada. ALBERTA: Flatbush, 12-IV-1960, 2♀ (ex pupae of *Odontomyia pubescens* Day). MANITOBA: 4 mi. N White-water, 30-VII-1958, 1♀. ONTARIO: Bells Corners, 22-VII-1941, 1♀; Ottawa, 1♀. United States. UTAH: Neola, 29-VI-1954, 1♀. WYOMING: South Pass City, 29-VII-1954, 1♀.

Biology. The two specimens from Flatbush, Alberta, were reared from pupae of *Odontomyia pubescens* (Diptera: Stratiomyidae).

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